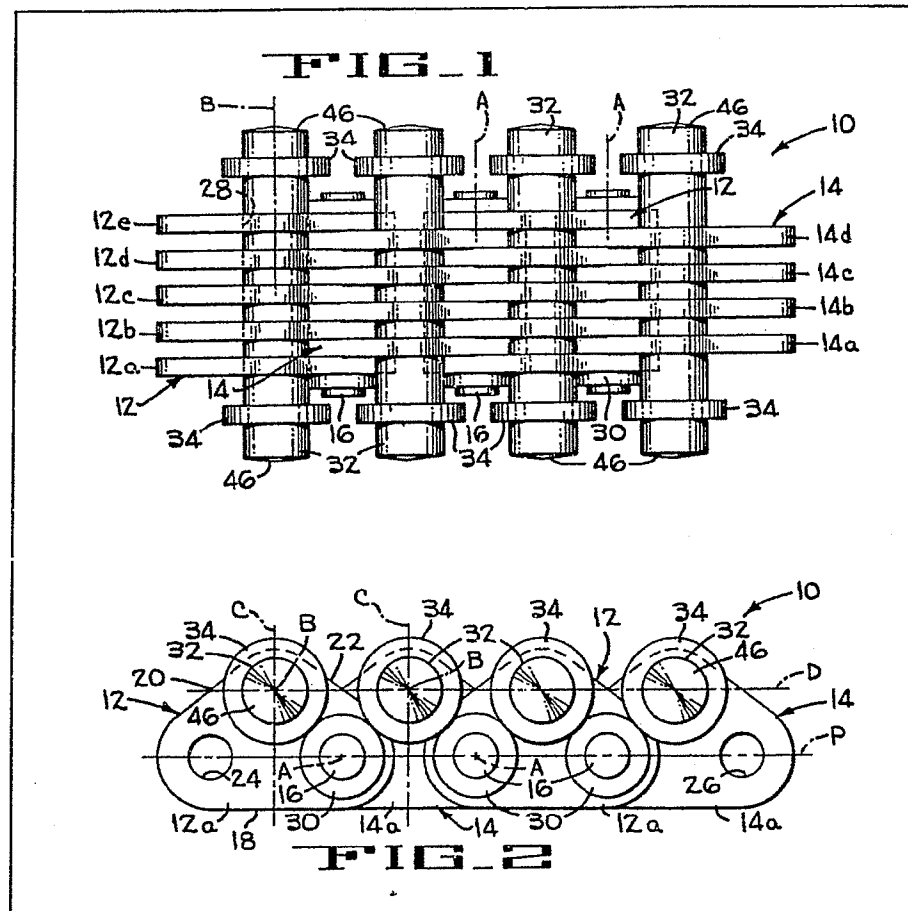


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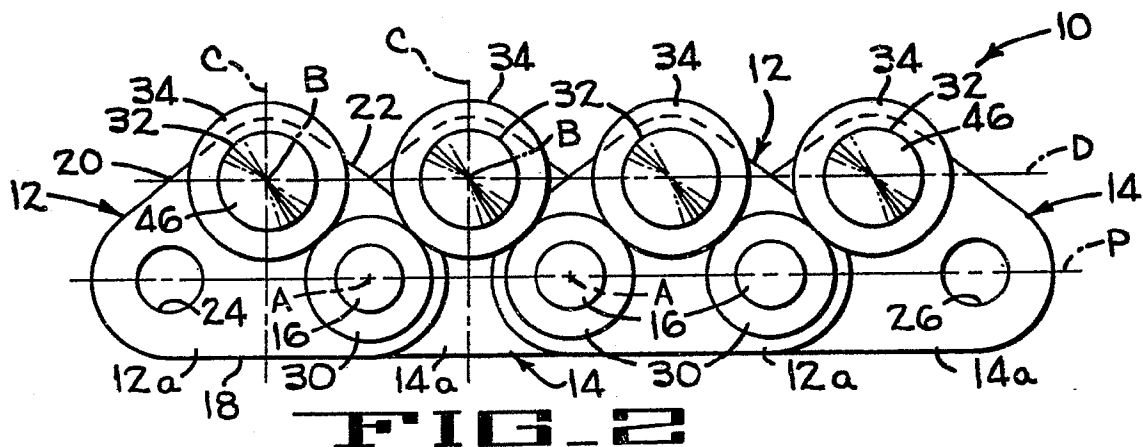
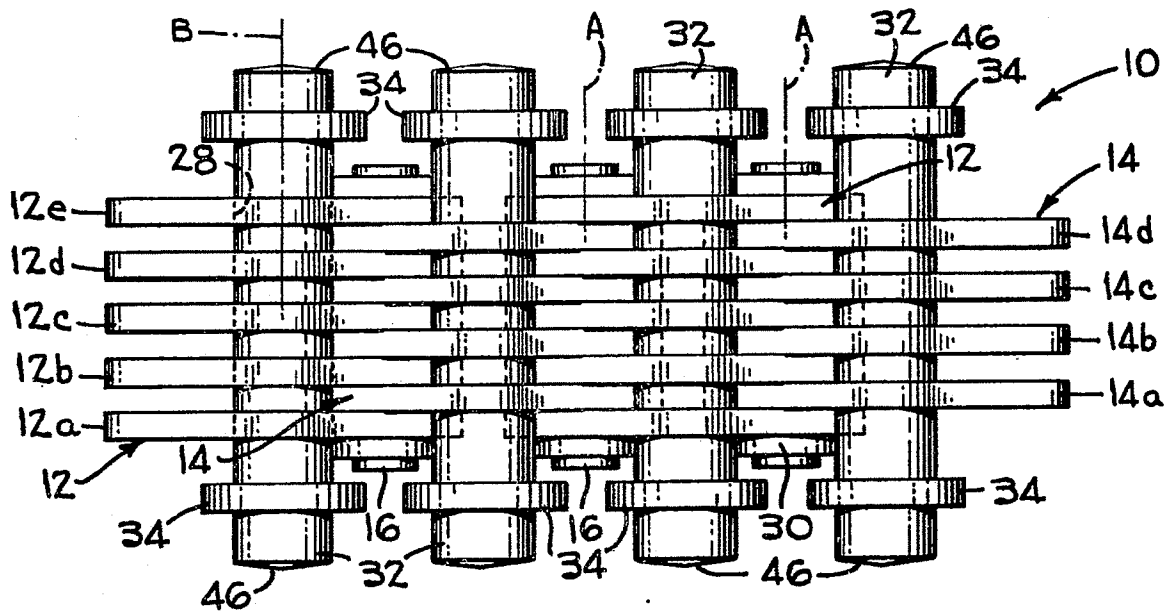
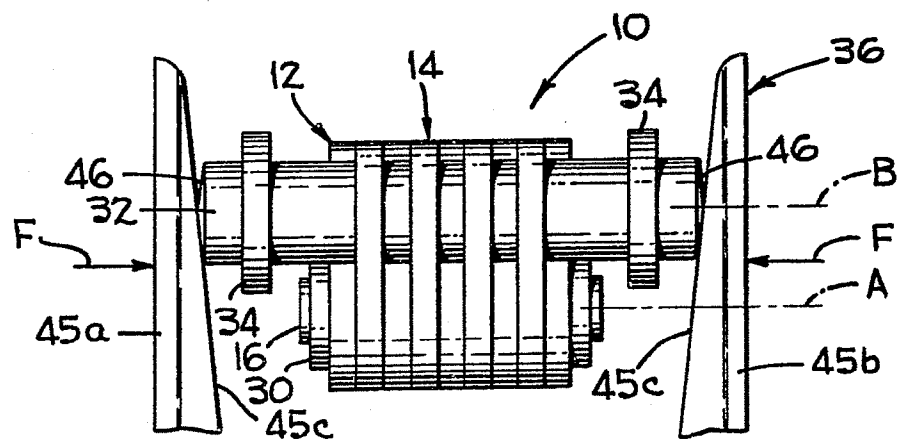
## (54) Drive chain

(57) A drive chain for a variable speed transmission has two groups of links 12, 14 pivotally connected together by pivot pins 16 lying on a pitch line. Drive pins 32 are loosely received in each group of links, on a drive line spaced from the pitch line, for engagement with pulleys of a variable speed transmission.

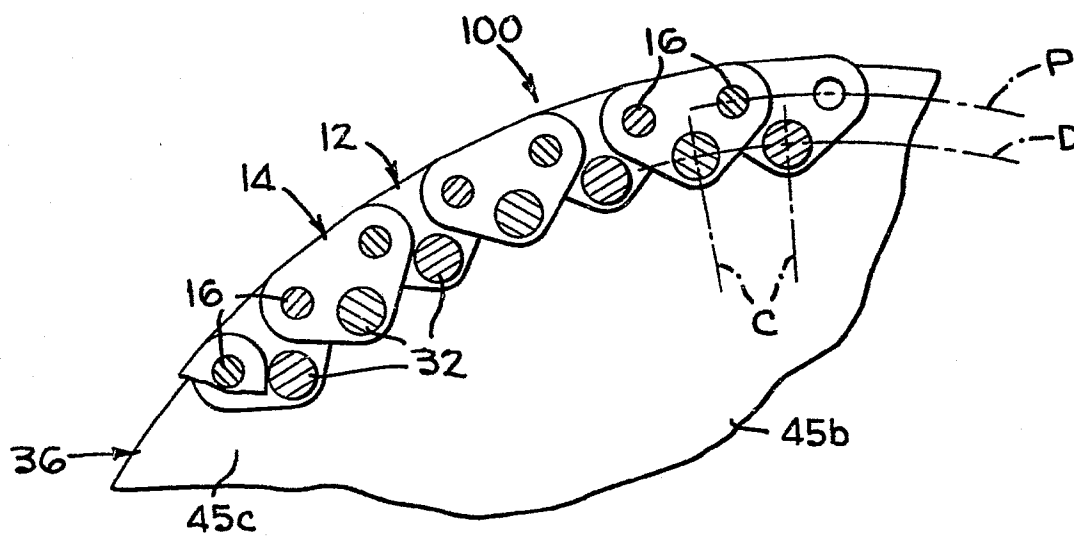
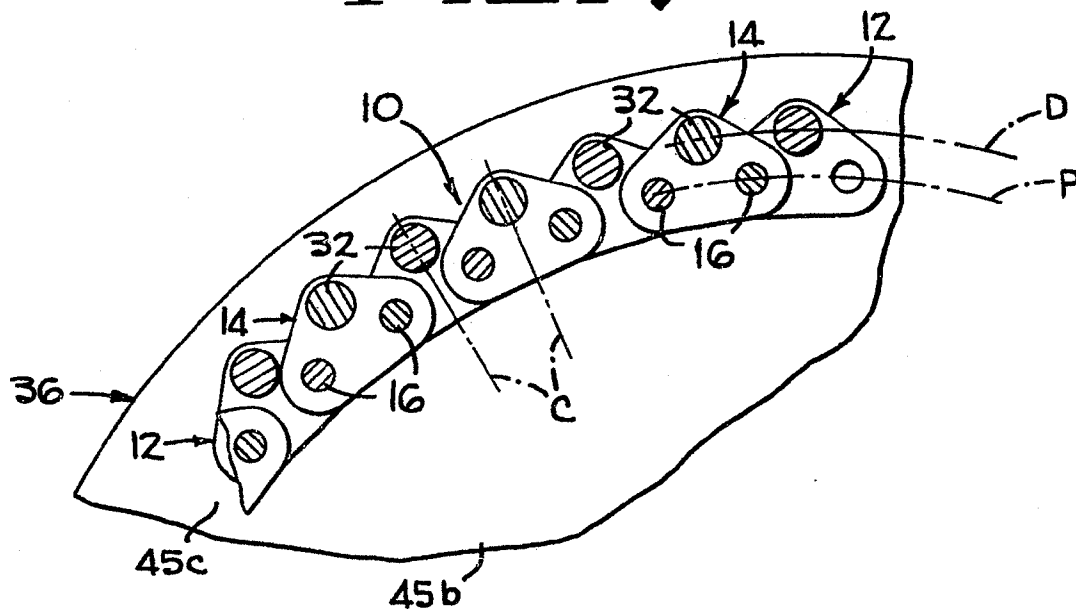


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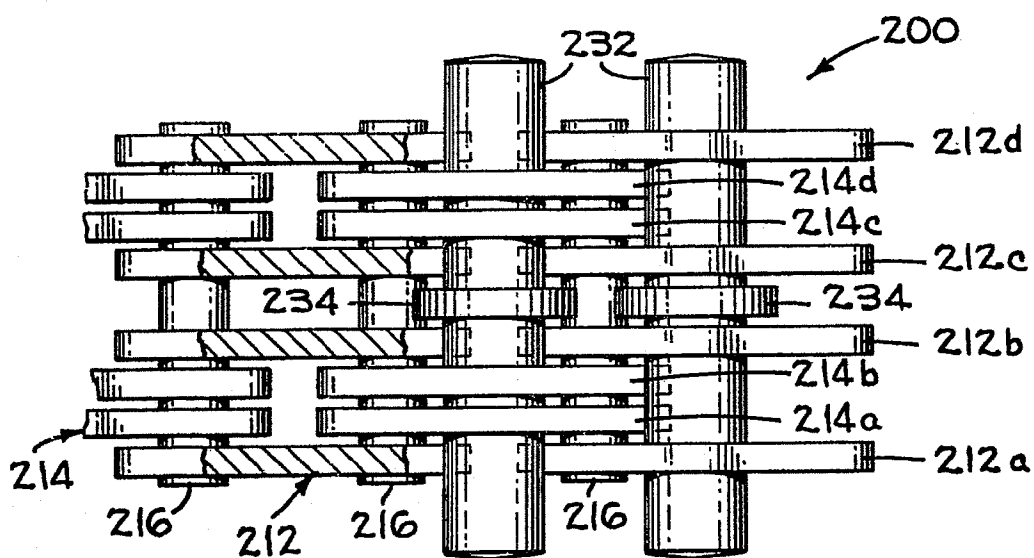
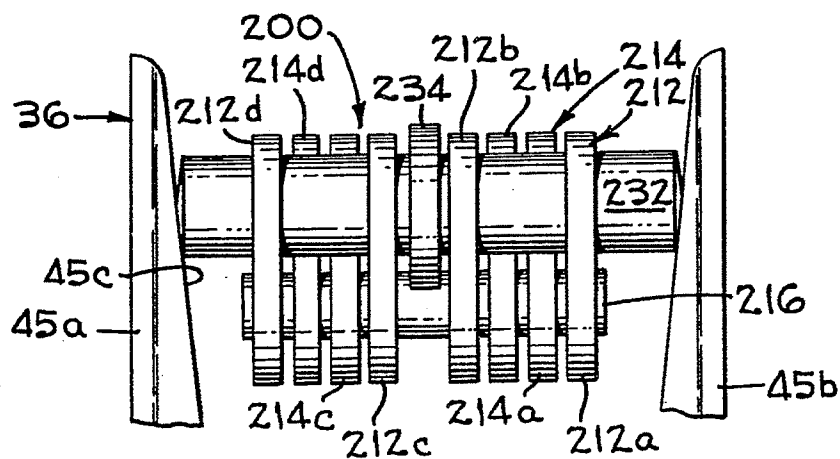
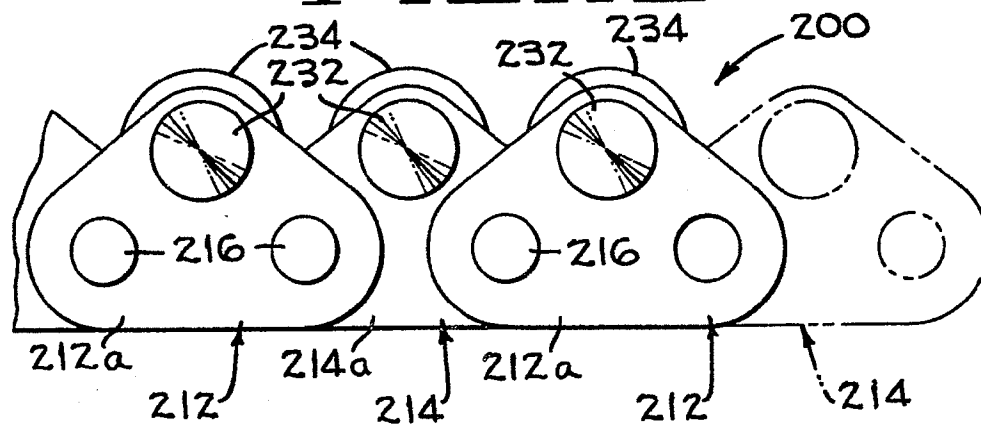
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**FIG. 1****FIG. 2****FIG. 3**



**FIG. 7****FIG. 8**

4/4

**FIG 9****FIG 10****FIG 11**

## SPECIFICATION

## Drive chain

The present invention relates to a drive chain and more particularly to a drive chain for a variable speed transmission.

In a variable speed transmission of the type shown, for example, in United States Patent No. 4,046,023, a pulley is securely mounted on each of two parallel shafts. Each pulley has two conical faces to receive therebetween an endless drive chain which, through the pulleys, connects the two shafts in driving relation. The spacing between the two conical faces of each pulley can be varied to alter the drive ratio between the two shafts.

Although there are many different types of drive chains, one of the most practical and effective is the type shown in United States Patent No. 2,550,431. This drive chain is made up of rigid links comprising, alternately, outer links and inner links pivotally connected together by pivot pins to define an endless chain. The ends of the pivot pins extend beyond the outer links for driving engagement with the smooth conical faces of the two pulleys mounted on the respective shafts of the transmission.

According to the invention, there is provided a drive chain for a variable speed transmission having two spaced apart pulleys with conical faces to receive the drive chain, said chain having a plurality of links pivotally connected in end to end relation at pivot joints lying on a pitch line, and a drive pin mounted in at least some of said links and having end faces for engagement with the walls of the pulleys, said drive pin extending through said links on an axis spaced from said pitch line to provide a force moment resisting relative twisting between the links at the pivot joints.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying diagrammatic drawings, in which:

Figure 1 is a plan view of the drive chain in accordance with the present invention;

Figure 2 is a side view of the chain of Figure 1;

Figure 3 is an end view of the chain of Figure 1, shown in driving engagement with the smooth conical walls of one of the pulleys of a transmission;

Figure 4 is a central section taken between the walls of the transmission pulleys showing the pitch line and the drive line of the chain of Figures 1 to 3;

Figure 5 is a view, taken as the view of Figure 3, of another embodiment of a drive chain constructed in accordance with the present invention;

Figure 6 is a view, taken as the view of Figure 4, showing the pitch line and the drive line of the chain of Figure 5;

Figure 7 is a fragmentary section of a portion of the chain of Figures 1 to 4, taken on a plane between the end retaining washers and showing

adjacent groups of links in driving engagement with a pulley;

Figure 8 is a fragmentary section of a portion of the chain of Figures 5 and 6, taken on a plane between the end retaining washers and showing adjacent groups of links in driving engagement with a pulley;

Figure 9 is a plan view of yet another embodiment of a drive chain constructed in accordance with the present invention;

Figure 10 is a side view of the drive chain of Figure 9.

Figure 11 is an end view of the drive chain of Figure 9, shown in driving engagement with the smooth conical walls of one of the pulleys of a transmission.

There is shown in Figure 1 a plan view of one embodiment 10 of the drive chain of the present invention. The chain 10 has alternate groups 12 and 14 of links pivotally connected together by pivot pins 16. Each group 12 consists of identical links 12a, 12b, 12c, 12d and 12e; and each group 14 consists of links 14a, 14b, 14c, and 14d, identical to each other and to the links of group 12. The links of group 12 are interdigitated at each end with the links of the adjacent groups 14; and the links of group 14 are interdigitated at each end with the links of the adjacent groups 12.

Each link of both groups is of generally triangular configuration, with rounded corners. For illustrative purposes, the generally triangular shape of the links is isosceles in form, with a base 18 and equal sides 20, 22. Openings 24 are provided at one base corner of the links, openings 26, of equal size to openings 24, are provided at the other base corner of the links, and a substantially larger opening 28 is provided at the apex of the triangular links.

A pivot pin 16 is received in the openings 26 of one group 12 of links, and also through the openings 24 of the adjacent group 14 of links. Another pivot pin 16 is received in the openings 26 of the latter group 14 of links and also through the openings 24 of the next adjacent group 12 of links. The pins 16 are loosely received in the openings 24 and 26 of the groups 12 and 14, and are held in the openings by retaining washers 30 secured to the respective ends of the pins. Thus, the groups 12 and 14 of links are pivotally connected together, in alternating sequence, by the pivot pins 16 which have central longitudinal axes A defining pivot axes. The pivotal connection of the adjacent groups of links to the pivot pins define pivot joints. Although the pivot joints described above are preferred, the adjacent groups 12 and 14 of links can be pivotally connected together by other pivot joints, such as those shown in United States patents 3,742,776 or 3,661,025. The transmission drive chain 10 is endless, as indicated in Figure 4.

A line P connecting the central longitudinal axes A of the pivot pins 16, as viewed in Figure 2, constitutes a pitch line through the pins. The line P takes the form of a loop (Figure 4) in the endless drive chain illustrated.

A drive pin 32, having a central longitudinal axis B, is loosely received in the openings 28 of each group 12 and 14 of links of the drive chain. Each pin 32 is retained in a group of links by retaining washers, or members, 34 secured to opposite ends of the pin. The axis B of the drive pin extending through each link lies on an axis C which is perpendicular to, and bisects into two equal parts, that segment of pitch line P which extends between the two pivot pins 16 passing through each link, as shown in Figure 2. The axes B also lie on a drive line D which, for the illustrated endless loop drive chain, takes the form of a loop, as shown in Figure 4. The drive pin 32 could, alternatively, be loosely received in bushings which are pressed into openings 28.

The drive chain 10 is received in a pulley 36 mounted on an input shaft 38 of a transmission (indicated schematically at 40), and in a like pulley 42 mounted on an output shaft 44 of the transmission. As shown in Figure 3, each pulley has opposing walls 45a, 45b, each with smooth conical inner faces 45c which are engaged by a portion of the conical end faces 46 of the drive pins 32. The pulley walls are biased by forces F toward each other (by mechanism in the transmission, not shown), to maintain the chain taut in a known manner, such as disclosed in United States patent 4,046,023.

In the chain 10 of the embodiment of the invention in Figures 1 to 4, inclusive, the drive loop D falls outside the pitch loop P, as shown in Figure 4. In the chain 100 of the embodiment of the invention shown in Figures 5 and 6, the drive loop D falls inside the pitch loop P, as shown in Figure 6.

Adjacent groups of links 12 and 14 of the chain 10 are shown, in Figure 7, with the drive pins 32 engaged with the walls of one of the pulleys on which the chain is received. It will be noted that the axes C of the adjacent groups are not parallel and converge as they extend radially inwardly. Since the pivot pins 16 are spaced radially inwardly from the drive pins 32, the drive pins are spaced a greater distance apart on the drive loop D than are the pivot pins on the pitch loop P.

Adjacent groups 12 and 14 of links (which may be identical to groups 12 and 14 of chain 10) of chain 100 are shown, in Figure 8, with the drive pin 32 engaged with the walls of one of the pulleys on which the chain is received. In chain 100, the axes C of the adjacent groups 12 and 14 also converge as they extend inwardly, and since the pivot pins 16 are, in this embodiment, spaced radially outwardly from the drive pins 32, the drive pins are spaced apart a smaller distance than the pivot pins. Thus, assuming the links 12 and 14, and the pins 32, of chains 10 and 100 are of equal length, and the drive pins 32 of chain 100 engage the walls of the pulleys at the same distance from the center of the pulleys as the drive pins of chain 10, the chain 10 of Figure 7 must be shorter than the chain 100 of Figure 8. It will be noted, however, that under these circumstances, more drive pins of chain 100 will be engaged with the

pulleys than drive pins of chain 10. Although the additional drive pin engagement of chain 100 is advantageous, it is our opinion that the arrangement of chain 10 undergoes less twisting during operation and is, therefore, the preferable embodiment.

In other respects, the chain 100 of Figures 5 and 6 is identical to the chain 10 of Figures 1 to 4. In fact, the chain of either embodiment can be turned upside down and used as the chain of the other embodiment (with a modification in length if the drive pins are to engage the pulleys at the same distance from the center of the pulleys). In both embodiments of the invention, the drive loop D is spaced from the pitch loop P.

Yet another embodiment of the invention is shown in Figures 9, 10 and 11. The chain 200 of Figure 9 has two different groups of links, groups 212 and groups 214, pivotally connected alternately in an endless loop. The links of both groups are identical to the links of groups 12 and 14 previously described. Each link of each group receives a pivot pin 216 at its base corners, and each receives a drive pin 232 at its apex. The links of group 212 (212a, 212b, 212c, 212d) are tightly received on pivot pins 216 in spaced apart relationship. One pair (212a, 212b) of links of group 212 on one end of pivot pin 216 receives therebetween two links (214a, 214b) of group 214, which are loosely mounted on pivot pin 216. The other pair (212c, 212d) of links of group 212 on the other end of pivot pin 216 receives therebetween two other links 214c, 214d of group 214 which are also loosely mounted on pivot pin 216. Drive pins 232 are loosely received in the links of both groups for axial and rotational movement therein. A retaining washer, or member, 234 is tightly secured to the center of the drive pins, between the links 212b and 212c. These washers thereby limit the axial movement of the pins 232 received in both the links of group 212 and the links of group 214 by engagement of the washers with the links 212b or links 212c.

In a typical previously proposed drive chain (as shown, for example, in the United States patent 2,550,431), driving engagement with the pulley is made on the pitch line by the pivot pins of the drive chain. In the previously proposed arrangement, and in any arrangement where the driving pins are located on the pitch line, the size of the driving pins is limited. Since two or more pivot pins of each link must be located on the pitch line, the driving pins cannot be as large as a single drive pin, such as drive pin 32, located in a position on the link spaced from the pitch line. In the three embodiments disclosed herein, the diameter of the drive pin is substantially greater than the diameter of the pivot pins (almost 50% greater in the illustrated embodiments). For a given chain pitch size, with the larger drive pins, greater axial force can be applied to pin ends by the pulley walls without exceeding surface contact stress limits (Hertz stress limit), permitting the transmission of greater power.

Another advantage in the drive pin

arrangement described, accruing from the spacing between the drive pins and the pitch loop, is the added stability of the chain. With the drive pins on the pitch line, twisting of the chain about that line (which occurs in small increments at each pivot joint) can occur during operation. As the incremental twist between adjacent groups of

links accumulates during operation, the drive pins can become cocked between the pulleys for poor engagement with the pulley walls and loss of power.

With the improved drive pin arrangement disclosed, the drive pins are spaced above or below the pivot pins. The pivot pins are the potential source of the accumulated twist, and, by virtue of this spacing, the drive pins serve to hold the chain against twisting in a way that no drive pin or pins on the pitch line could. Thus, if the chain is initially installed without twist, twist is less likely to start in the chain described than with a chain having drive pins on the pitch line. Although the links can shift laterally on the drive pins, because of the spacing between the links and washers 34 (or 234), the drive pins reduce the tendency for twist between the groups 12 and 14 (or groups 212, 214) of links at the pivot joints defined by the pins 16.

Although each group of links in the drive chain of the present invention may have as few as two links in side by side relationship, we prefer to use more links, as shown in the embodiments of Figure 1, Figure 5 and Figure 9.

#### CLAIMS

1. A drive chain for a variable speed transmission having two spaced apart pulleys with conical faces to receive the drive chain, said chain having a plurality of links pivotally connected in end to end relation at pivot joints lying on a pitch line, and a drive pin mounted in at least some of said links and having end faces for engagement with the walls of the pulleys, said drive pin extending through said links on an axis spaced from said pitch line to provide a force moment resisting relative twisting between the links at the pivot joints.

2. A drive chain according to claim 1, wherein said chain has a plurality of groups of links pivotally connected in interdigitated end to end relation by pivot pins lying on said pitch line, a respective said drive pin larger than said pivot pins extending through each of said groups of links on an axis spaced from said pitch line, said drive pins having conical end faces for engagement with the walls of the pulleys.

3. A drive chain according to claim 2, wherein said drive chain is endless with said pitch line defining an endless pitch loop, and wherein said drive pins lie in an endless drive loop outside the endless pitch loop.

4. A drive chain according to claim 2, wherein said drive chain is endless with said pitch line defining an endless pitch loop, and wherein said drive pins lie in an endless drive loop inside the endless pitch loop.

5. A drive chain according to any one of claims

1 to 5, wherein the drive pins are loosely received in the links for axial and rotational movement relative thereto, and retaining members are secured on the ends of the drive pins in spaced relation to the links to limit the axial movement of the drive pins relative to the links.

6. A drive chain according to any one of claims 1 to 5, wherein the links are of generally triangular configuration, said links each having a base and an apex, and each having an opening at each end of the base and an opening at the apex, a respective said pivot pin being received in each base opening to pivotally connect the links in end to end relationship, and a respective said drive pin being received in each apex opening.

7. A drive chain according to claim 1, comprising groups of links of generally triangular configuration having a base and an apex, each group having at least two links in spaced apart side by side relationship, and each link of each group having an opening at each end of the base and having an opening at the apex, a respective pivot pin being received in the base openings to pivotally connect the groups of links in end to end relationship, and a respective said drive pin being received in each apex opening.

8. A drive chain according to claim 6 or claim 7, in which the drive pins are substantially larger than the pivot pins.

9. A drive chain for a variable speed transmission having two spaced apart pulleys with conical faces to receive the drive chain, said chain having a plurality of groups of links pivotally connected in interdigitated end to end relation by pivot pins at pivot joints lying on a pitch line, and a drive pin larger than said pivot pins extending through each of said groups of links on an axis spaced from said pitch line, said drive pins having conical end faces for engagement with the walls of the pulleys.

10. A drive chain for engagement with conical faced pulleys, said chain having a plurality of links pivotally connected in end to end relation at pivot axes intersecting a pitch line, drive pins extending through said links parallel to said pivot axes and spaced from said pitch line, said drive pins having end faces for engagement with the conical faces of the pulleys, the drive pins being loosely received in the links for axial and rotational movement relative thereto, and retaining members secured on the ends of the drive pins in spaced relation to the links to limit the axial movement of the drive pins relative to the links.

11. A drive chain for engagement with conical faced pulleys, said chain having a plurality of links pivotally connected in end to end relation at pivot axes intersecting a pitch line, drive pins extending through said links parallel to said pivot axes and spaced from said pitch line, said drive pins having end faces for engagement with the conical faces of the pulleys, the drive pins being loosely received in the links for axial and rotational movement relative thereto, and retaining members secured on the drive pins between, and in spaced relation to, the links to permit the axial movement of the



drive pins relative to the links.

12. A drive chain for engagement with the opposing inner faces of a pulley comprising links of generally triangular configuration, said links
- 5 each having a base and an apex, and each having an opening at each end of the base and an opening at the apex, pivot pins received in each base opening to pivotally connect links in end to end relationship, and a drive pin received in each
- 10 apex opening, said drive pin having opposite end faces to engage the opposing inner faces of the pulley.
13. A drive chain for engagement with the opposing inner faces of a pulley comprising groups
- 15 of links of generally triangular configuration having a base and an apex, each group having at least two links in spaced apart side by side relationship, and each link of each group having an opening at each end of the base and having an opening at the

- 20 apex, a pivot pin received in the base openings to pivotally connect the groups of links in end to end relationship, and a drive pin received in each apex opening.

14. A drive chain for engagement with the
- 25 opposing inner faces of a pulley comprising groups of links of generally triangular configuration having a base and an apex, each group having a plurality of links in spaced apart side by side relationship interdigitated with the links of adjacent groups,
- 30 each link of each group having an opening at each end of the base and having an opening at the apex, a pivot pin received in the base openings to pivotally connect the group of links in end to end relationship, and a drive pin substantially larger
- 35 than the pivot pins received in each apex opening.

15. A chain substantially as hereinbefore described with reference to the accompanying drawings.